

A STUDY OF THE AQUATIC AND MARSHLAND PLANTS OF JHALAWAR DISTRICT, RAJASTHAN^{1,2}

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The present study gives an account of the floristic composition, phenology, ecology and detailed distribution of aquatic and marshland vegetation of Jhalawar district. The area has remained under-explored on account of its lack of facilities. Important aquatic habitats of the area have been selected for detailed study and a description of each habitat alongwith characteristic species occurring there, has been given. The hydrophytes have been classified into six life-forms based on their contact with soil, water and air. Proportion of monocots to dicots with regard to species (1:0.8) is interesting as the hydrophytic vegetation is represented by a better number of monocotyledons in this area. Four species have been mentioned as new records for Rajasthan. Detailed distribution of the species in the area surveyed has been tabulated and important aquatic and marshland communities are described.

INTRODUCTION

The flora of Rajasthan has been studied in great detail since the publication of Blatter and Hallberg's (1918-21) "The Flora of the Indian Desert". In recent years, studies have also been undertaken on the hydrophytic and marshland flora of the terrain (Ratnam & Joshi 1952; Sarup 1958, 1961; Nair & Kanodia 1959; Vyas 1962, 1964; Gupta 1966; Maheshwari & Singh 1974; see also Biswas & Calder 1937; Subramanyam 1962; Majumdar 1971). There is, however, a lacuna in our knowledge of the structure and composition of aquatic and marshland flora of Jhalawar district in south-eastern part of Rajasthan. The present paper includes fairly comprehensive data on the floristic composition, phenology, ecology and the distribution of hydrophytes from Jhalawar district. The region was surveyed in different

seasons during the years 1968 to 1973 and the specimens collected during this study are preserved in the Herbarium of Floristic Botany Division, National Botanic Gardens, Lucknow (LWG).

LOCATION, SOIL AND CLIMATE

Jhalawar district is situated in the southeast corner of Rajasthan at the edge of Malwa plateau between 23°45' and 24°52' N. latitude, and 75°27' and 76°56' E. longitude. It is bounded on the north by Kotah district, on the east, west and south by Madhya Pradesh. The district occupies an area of about 2310 sq. kilometres and is situated at an altitude of 302 m above m.s.l.

The climate of the area is dry monsoonic and shows three well marked seasons, namely rainy, winter and summer seasons. During the months of May and June, the mean maximum temperature of 43°C has been recorded. The mean minimum temperature of 7°C has been recorded in the months of December and January. Out of the total annual rainfall, the

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months of July to October receive 700-900 mm of rains which is 99% of the total fall of the year. The rains are infrequent during winter. The soils can be broadly classified into clay and clay-loam types. The clay content varies from 25-48%, and shows 25-50% silt and 25-50% sand. The dispersion co-efficient has been found to be very low, thus indicating a good water-table structure and a resistance to detachability by flood water.

HABITATS AND PLANT ASSOCIATIONS

The study was conducted over a greater part of the district with special reference to the following habitats.

Rivers and streams: The rivers and streams of this district belong to Chambal system and they generally flow from south to north. For the sake of convenience, they may be classified into two groups—(i) Western rivers, (ii) Eastern rivers. Ahu and Kalisindh, with their many tributaries, belong to the first category. The source of Ahu is a tank in Madipur tehsil of Madhya Pradesh. It flows northwards forming boundaries between Dag and Pirawa and Pachpahar and Jhalarapatan tehsils of the district. On meeting Mukandara hills, the river is deflected north to east and then abruptly changes its course to south-east to join Kalisindh near Gagrain. The important tributaries of Ahu include Piplaj, Kyasri, Kantli and Rewa. Kalisindh, entering the district from Madhya Pradesh, flows northwards forming boundaries between Bakani and Jhalarapatan tehsils. Its important tributary is Chandrabhaga which is dammed near Mundliakheri to form a tank. It joins Kalisindh near Khandia village.

Parwan is the important river of the second group. It is formed by the combination of Ajar and Ghorapachar rivers which flow northwards and meet near Manoharthana

town. Parwan flows north-westwards through Manoharthana tehsil and then turns westwards forming the northern boundary of Aklera tehsil. Eventually, it joins the Kalisindh. On its way it receives Kalikhar, Newaj, Ghar, Ujar, Nagli and Rooli tributaries.

During the monsoon season, the rivers flow very swiftly, regularly causing floods. But, by the summer, they are almost all dry excepting a few places where a trickle of water is preserved in the pools which are the most favourable spots for the growth of aquatics. Though, the river beds are rocky with big boulders, they carry a considerable amount of sand which is poor in humus, porosity and nitrate content, and is rich in carbonates and chlorides. The soils, geology, seepage, silting, substratum, physiochemical properties of water and the biotic interferences are almost identical in all the rivers. The true aquatic species are very poorly represented in these habitats, and nowhere in the district attached aquatics dominate the vegetation. The free-floating or suspended submerged forms dominate the aquatic plant communities of the rivers and their tributaries. The paucity of aquatic species, especially of attached forms, is mainly due to the rocky bottom of the rivers.

The amphibious emergent species are comparatively better represented in these habitats. The vegetation is more luxuriant and continuous along the banks of the rivers, perhaps, due to better soil formation. However, patches of emergent forms, particularly *Cyperus*, *Fimbristylis*, *Scirpus* and *Crinum* together with *Hydrilla*, *Ceratophyllum*, *Zannichellia* and *Potamogeton*, may be noted in midstream also. Some exposed rocks in the centre of the rivers are covered with *Rotala serpyllifolia* (Roth) Bremek. This indicates that there is no particular zonation of plants in the rivers. However, *Nymphaea* and *Nymphoides* disappear

gradually towards the shore. The following plant associations have been noted in the rivers at different places.

Ceratophyllum-Hydrilla-Nymphoides
Hydrilla-Zannichellia-Potamogeton
Hydrilla-Nymphoides-Nymphaea
Potamogeton-Ceratophyllum-Vallisneria
Cyperus-Fimbristylis-Scirpus-Zannichellia
Polygonum-Cyperus-Scirpus
Marsilea-Fimbristylis-Polygonum
Ammannia-Alternanthera-Eclipta
Phyla-Eclipta-Bacopa-Marsilea
Cyperus-Phyla-Eclipta
Ammannia-Caesulia-Bacopa-Scirpus
Typha-Caesulia-Cyperus

Besides these, there are pure communities of *Eichhornia crassipes* (Mart.) Solms, *Potamogeton pectinatus* L., *Rotala rotundifolia* (Ham.) Koehne and *R. serpyllifolia* (Roth) Bremek. Members of *Cyperaceae* are sparsely distributed among the rocks in the rivers.

Tanks and Lakes: There are two artificial lakes—Kadila and Mansarowar in the district which are formed by building embankments between two parallel ridges of Mukandara in the north-east of Asnawar town. These lakes support thick growth of wetland plants and only few true aquatics. The other large sized tanks of the area are Chandra Sarowar—in the south of Jhalawar, Durgapura tank—near Durgapura village, Kishan Sagar—in the west of Jhalawar, Tandia tank—near Khandia village, Gomti Sagar—near Jhalarapatan, Mandawar tank—near Mandawar village, Gordhanpura tank—near Gordhanpur village, Kadila tank—in the north-west of Asnawar etc. In Pachpahar tehsil, Naka-sarna and Niwas-ghatod, and in Bakani tehsil, the Molikia are the notable tanks. Most of these tanks lie in depressions and are fed by a number of ‘Nallas’ during the rainy season. They are being used for irrigation and are exposed to heavy biotic in-

terferences by the way of weed removal, washing of clothes and animals. They are more or less naked in the centre. However, the margins often have a sparse growth of *Hydrilla verticillata* (Linn. f.) Royle, *Vallisneria natans* (Lour.) Hara, *Potamogeton crispus* Linn. and *Zannichellia palustris* Linn. together with certain algae (*Spirogyra* sp. and *Oedogonium* sp.). The free floating plants are mostly represented by *Spirodela polyrrhiza* Schleid., *Lemna paucicostata* Hegelm. and *Azolla pinnata* R. Br. Occasionally, the species of *Nymphaea* and *Nymphoides* may also be noted in these habitats. The marshy banks support comparatively thick growth of emergents, particularly the members of *Cyperaceae* together with many creeping plants like *Phyla nodiflora* (L.) Greene, *Alternanthera sessilis* (L.) DC., *Eclipta prostrata* (L.) Linn., *Marsilea minuta* L. etc.

The interesting tanks from hydrophytic vegetation point of view are situated in the villages of Dalanpur, Bakani, Brahmpura, Kushalpura, Patlai, Rijol, Richwa, Dhudalia, Ratapura, Singhpur, Unhel, Semli, Sheopura, Panwasa, Bager, Bordi, Jolpa, Mirsoli, Adakeri, Govindpura, Koldi-choti and Sherpura. The depth of these tanks varies from 1-3 feet and they are mostly fed by run off water during rainy season. They hold a variety of aquatic and amphibious plants. The vegetation of some of these tanks shows an interesting zonal distribution. The gently sloping marginal zone exhibits a carpet of marshland species; the shallow middle zone supports a rich emergent vegetation; and the central zone, which is always under water, is favourable for the attached and floating aquatic forms.

A. Central zone associations:

1. *Zannichellia-Hydrilla-Nymphoides*
2. *Nymphaea-Ceratophyllum-Potamogeton*

3. *Azolla-Spirodela-Lemna*
4. *Nymphaea-Nymphoides-Zannichellia*
5. *Nymphaea-Hydrilla*
6. *Trapa-Hydrilla-Ceratophyllum*

B. Middle zone associations:

1. *Typha-Aeschynomene-Fimbristylis-Hydrilla*
2. *Cyperus-Scirpus-Ceratophyllum*
3. *Typha-Caesulia-Cyperus-Zannichellia*

C. Marginal zone associations:

1. *Phyla-Marsilea-Eclipta*
2. *Cyperus-Ammannia-Alternanthera*
3. *Ammannia-Alternanthera-Veronica*
4. *Cyperus-Phyla-Marsilea*
5. *Fimbristylis-Scirpus-Bacopa-Alternanthera*

Besides these, at certain places *Eichhornia crassipes* (Mart.) Solms, *Nechamandra alternifolia* (Roxb.) Thw. and *Potamogeton pectinatus* Linn. occur in pure stands.

Puddles, Ponds, Nallas and Rice-fields:

There is a number of shallow bodies of water distributed throughout the area in the form of Puddles and Ponds. The vegetation of these habitats is dominated by the species of *Fimbristylis*, *Cyperus*, *Aeschynomene*, *Typha*, *Monochoria*, *Limnophila*, *Veronica*, *Polygonum* etc. Among the floating forms, the species of *Lemna*, *Spirodela*, *Hydrilla*, *Zannichellia*, *Ceratophyllum*, *Eichhornia*, *Nymphoides* etc. are more common. The species of *Nymphaea* represent the group of attached forms. At certain places *Potamogeton pectinatus* Linn., *Nechamandra alternifolia* (Roxb.) Thw., *Pistia stratiotes* L. and *Typha angustata* Bory & Chaub. form pure communities. It is also in-

teresting to note that certain ponds devoid of aquatic and marshy vegetation when with water, maintain luxuriant growth of *Glossostigma spathulatum* (Hook. ex Wt.) Arn. ex Benth., *Dentella repens* (L.) Forsk. and *Polygonum plebeium* R. Br. as soon as the habitats become marshy.

There are many 'nallas' in the area which feed the large tanks and lakes. They maintain a thick growth of semi-aquatic or marshy plants in the post monsoon period. The most common species are *Aeschynomene*, *Typha*, *Hygrophila*, *Caesulia*, *Marsilea*, *Ottelia*, *Eclipta*, *Alternanthera*, *Bacopa*, *Veronica*, *Ipomoea*, *Ammannia*, *Bergia*, *Monochoria* etc. At certain places, where a trickle of water is preserved, an association of *Potamogeton-Zannichellia-Hydrilla* was noted. It is interesting to note that, though, the seeds of the species growing in 'nallas' are brought to the respective tanks fed by them, yet, the hydrophytic flora of the tanks is very poor. This is, perhaps, due to the rocky bottom, poor aeration and wide amplitude of water in the tanks and lakes.

Rice-fields are other favoured spots for the growth of aquatic and marshland plants. *Utricularia inflexa* Forsk. var. *stellaris* (Linn. f.) Taylor, *U. gibba* L. subsp. *exoleta* (R. Br.) Tayl., *Spirodela polyrrhiza* Schleid., *Lemna paucicostata* Hegelm., *Ammannia baccifera* L. and the members of *Cyperaceae* together with *Oryza sativa* L. behave like a community. It is also interesting to note that the seeds of weed species grow a few days later than crop-seeds and complete their life cycle before the crop is harvested, except the few members of *Cyperaceae* like *Fuirena wallichiana* Kunth. No zonal distribution of plant communities was noted in these habitats.

TABLE 1

SHOWING THE HABIT, FLOWERING PERIOD AND DETAILED DISTRIBUTION OF HYDROPHYTES AND MARSHLAND SPECIES*

Species	Habit	Flowering period	Localities		
			1	2	3
MARSILEACEAE					
<i>Marsilea minuta</i> Linn.	B	Aug.-Oct.	+	+	+
SALVINIACEAE					
<i>Azolla pinnata</i> R. Br.	A	Not seen	-	+	+
EQUISETACEAE					
<i>Equisetum ramosissimum</i> Desf. subsp. <i>ramosissimum</i>	E, F	Not seen	+	-	-
NYMPHAEACEAE					
<i>Nymphaea nouchali</i> Burm. f.	B	July-Nov.	+	+	+
<i>N. stellata</i> Willd.	B	July-Nov.	+	+	+
ELATINACEAE					
<i>Bergia ammanioides</i> Roxb.	E, F	Oct.-Dec.	+	+	+
<i>B. capensis</i> Linn.	E, F	Aug.-Nov.	-	-	+
PAPILIONACEAE					
<i>Aeschynomene indica</i> Linn.	E	July-Oct.	+	+	+
LYTHRACEAE					
<i>Ammannia baccifera</i> Linn.	E, F	July-Oct.	+	+	+
<i>A. multiflora</i> Roxb.	E, F	Aug.-Nov.	-	+	+
<i>Rotala indica</i> (Willd.) Koehne	E, F	Oct.-Feb.	-	-	+
<i>R. rotundifolia</i> (Ham.) Koehne	A	Dec.-March	+	-	-
<i>R. serpyllifolia</i> (Roth) Bremek.	F	Aug.-Nov.	+	-	-
GNAGRACEAE					
<i>Ludwigia adscendens</i> (Linn.) Hara	A	Aug.-Nov.	-	+	+
<i>L. perennis</i> Linn.	E, F	Aug.-Nov.	+	+	+
TRAPACEAE					
<i>Trapa bispinosa</i> Roxb.	A	Sep.-Dec.	-	+	+
RUBIACEAE					
<i>Dentella repens</i> (Linn.) Forst.	F	Jan.-March	-	+	+
COMPOSITAE					
<i>Caesulia axillaris</i> Roxb.	E, F	Sept.-Dec.	+	+	+
<i>Eclipta prostrata</i> (L.) Linn.	E, F	Most part of year	+	+	+
<i>Sphaeranthus indicus</i> Linn.	F	Oct.-Feb.	+	-	-
<i>Spilanthus paniculata</i> Wall. ex DC.	E	Dec.-April	-	-	+
LIMNANTHACEAE					
<i>Nymphoides cristatum</i> (Roxb.) Ktze.	B	Jan.-March	+	+	+

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Species	Habit	Flowering period	Localities		
			1	2	3
<i>N. indicum</i> (Linn.) Ktze.	B	Jan.-March	+	+	+
HYDROPHYLLACEAE					
<i>Hydrolea zeylanica</i> Vahl	E	Sept.-Oct.	-	-	+
BORAGINACEAE					
<i>Rotala aquatica</i> Lour.	E	Oct.-Feb.	+	-	-
CONVOLVULACEAE					
<i>Ipomoea aquatica</i> Forsk.	A, F	Dec.-March	+	+	+
SCROPHULARIACEAE					
<i>Bacopa monniera</i> (Linn.) Pennell	E, F	Sept.-Dec.	+	+	+
<i>Glossostigma spathulatum</i> (Hook. ex Wt.) Arn. ex Benth.	F	Dec.-Feb.	-	-	+
<i>Limnophila indica</i> (Linn.) Druce	E	Oct.-April	+	-	+
<i>Veronica anagallis-aquatica</i> Linn.	E, F	Jan.-March	+	+	+
LENTIBULARIACEAE					
<i>Utricularia inflexa</i> Forsk. var. <i>stellaris</i> (Linn. f.) Taylor	A	Oct.-Dec.	-	-	+
<i>U. gibba</i> Linn. subsp. <i>exoleta</i> (R. Br.) Tayl.	A	Jan.-April	-	+	+
ACANTHACEAE					
<i>Hemidelphis polyspermus</i> Nees	F	Sept.-March	+	-	+
<i>Hygrophila auriculata</i> (Schumach.) Heine	E, F	Oct.-March	-	+	+
VERBENACEAE					
<i>Phyla nodiflora</i> (Linn.) Greene	F	Throughout year	+	+	+
AMARANTHACEAE					
<i>Alternanthera paronychioides</i> St. Hil.	F	Sept.-Jan.	-	+	+
<i>A. sessilis</i> (Linn.) DC.	F, E	Most part of the year	+	+	+
POLYGONACEAE					
<i>Polygonum barbatum</i> Linn. subsp. <i>gracile</i> Dan.	E	Aug.-Dec.	+	+	+
<i>P. glabrum</i> Willd.	E	Aug.-Nov.	+	+	+
<i>P. plebeium</i> R. Br.	F	Aug.-Nov. & March-June	+	+	+
CERATOPHYLLACEAE					
<i>Ceratophyllum demersum</i> Linn.	C	July-Oct.	+	+	+
HYDROCHARITACEAE					
<i>Hydrilla verticillata</i> (Linn. f.) Royle	C	July-Oct.	+	+	+
<i>Nechamandra alternifolia</i> (Roxb.) Thw.	C	Sept.-Jan.	-	+	+
<i>Ottelia alismoides</i> (Linn.) Pers.	D	Jan.-March	+	-	+
<i>Vallisneria natans</i> (Lour.) Hara	D	Jan.-April	+	+	+
AMARYLLIDACEAE					
<i>Crinum defixum</i> Ker-Gawl.	E	Most part of the year	+	-	-

Species	Habit	Flowering period	Localities		
			1	2	3
PONTEDERIAACEAE					
<i>Eichhornia crassipes</i> (Mart.) Solms	A	May-Oct.	+	+	+
<i>Monochoria hastata</i> (Linn.) Solms	E	Aug.-Nov.	-	+	+
<i>M. vaginalis</i> (Burm. f.) Presl.	E	Aug.-Nov.	-	-	+
TYPHACEAE					
<i>Typha angustata</i> Bory & Chaub.	E	July-Aug.	+	+	+
ARACEAE					
<i>Pistia stratiotes</i> Linn.	A	April-June	-	+	+
LEMNACEAE					
<i>Lemna paucicostata</i> Hegelm.	A	Not seen	-	+	+
<i>Spirodela polyrrhiza</i> Schleid.	A	Oct.-Jan.	+	+	+
POTAMOGETONACEAE					
<i>P. perfoliatus</i> Linn.	D	Feb.-May	+	+	+
<i>P. pectinatus</i> Linn.	C	Jan.-March	+	-	+
<i>P. perfoliatus</i> Linn.	D	Feb.-May	+	-	-
ZANNICHELLIACEAE					
<i>Zannichellia palustris</i> Linn.	C	Feb.-March	+	+	+
NAJADACEAE					
<i>Najas minor</i> Linn.	C	Sept.-Dec.	+	-	-
ERIOCAULACEAE					
<i>Eriocaulon quinquangulare</i> Linn.	E, F	Dec.-April	-	+	+
CYPERACEAE					
<i>Cyperus alopecuroides</i> Rottb.	E	Aug.-Dec.	+	+	+
<i>C. compressus</i> Linn.	E, F	Aug.-Dec.	+	+	+
<i>C. digitatus</i> Roxb.	E, F	July-Sept.	+	-	-
<i>C. difformis</i> Linn.	E, F	Sept.-Dec.	+	+	+
<i>C. eleusinoides</i> Kunth	E	Sept.-Feb.	+	+	+
<i>C. exaltatus</i> Retz.	E	Aug.-Nov.	+	-	+
<i>C. flavidus</i> Retz.	E, F	Dec.-March	+	+	+
<i>C. iria</i> Linn.	E, F	Aug.-Nov.	+	+	+
<i>C. michlianus</i> (L.) Link subsp. <i>pygmaeus</i> (Rottb.) Asch. & Graebn.	F	July-Oct.	+	+	+
<i>C. niveus</i> Retz.	F	July-Nov.	-	+	-
<i>C. pangorei</i> Rottb.	E	Dec.-April	+	+	+
<i>C. pumilus</i> Linn.	F	Aug.-Nov.	+	-	+
<i>C. rotundus</i> Linn.	E, F	July-Dec.	+	+	+
<i>Eleocharis atropurpurea</i> Kunth	E	Jan.-May	-	-	+
<i>Fimbristylis aestivalis</i> Vahl	E, F	Sept.-Dec.	+	+	+
<i>F. ovata</i> (Burm. f.) Kern	F	Aug.-Oct.	-	-	+
<i>F. quinquangularis</i> Kunth	E, F	Aug.-Nov.	+	+	+
<i>Fuirena wallichiana</i> Kunth	E, F	Sept.-Jan.	-	-	+

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Species	Habitat	Flowering period	Localities		
			1	2	3
<i>Scirpus affinis</i> Roth	E	Jan.-May	-	-	+
<i>S. littoralis</i> Schrad.	E, F	Feb.-April	+	-	+
<i>S. roylei</i> (Nees) Parker	E, F	July-Nov.	-	-	+
<i>S. supinus</i> Linn.	E, F	Oct.-Dec.	+	+	+
GRAMINEAE					
<i>Echinochloa colonum</i> (Linn.) Link	E, F	Jan.-Oct.	+	+	+
<i>Hygroryza aristata</i> Nees	A	April-June	-	+	-
<i>Isachne miliacea</i> Roth	E	Nov.-Feb.	-	-	+
<i>Oryza sativa</i> Linn.	E, F	Oct.-Nov.	-	-	+
<i>O. rufipogon</i> Griff.	E	Sept.-Nov.	-	-	+
<i>Paspalidium punctatum</i> Stapf	E	Sept.-Nov.	+	+	+
<i>Phragmites maxima</i> Blatt. & McC.	E	Sept.-Jan.	+	-	-

* Explanation of symbols:

+ = present; - = absent; A = Free floating; B = Attached with floating leaves and/or shoots; C = Suspended submerged; D = Attached submerged; E = Aquatic or amphibious emerged; F = Marshland plants; 1 = Rivers and streams; 2 = Tanks and lakes; 3 = Puddles, ponds and rice-fields.

DISCUSSION

The area, apparently unsuitable for the growth of luxuriant vegetation, is rich in aquatic and marshland species. The present study shows that 88 species belonging to 56 genera and 34 families inhabit the riverain and marshland areas of the district. The floristic composition of the vegetation is as follows:

	Family	Genera	Species
Pteridophytes	3	3	3
Monocotyledones	12	26	47
Dicotyledones	19	27	38

This indicates that the monocots are less represented by their families and genera, and are better represented in their species. Of these species 27 show restricted distribution and are confined to a single habitat and 40 occur throughout the area. The amplitude of water level, physical and chemical nature of the sub-

strata and water, and more specially the biotic activities seem to control the distribution of these species. The type of bottom is also very important in the ecesis of hydrophytes. The poorest growth occurs on gravel or rock, whereas the best growth is organic, silty or loamy soils. In this area, 12 species are free floating, 5 attached with floating leaves and/or shoots, 6 suspended submerged, 4 attached submerged, 21 aquatic or amphibious emerged, 12 marshland and 28 species occur both in aquatic and marshy habitats. About five species form their communities and the rest are either sparsely distributed or grow in different associations. The six dominant families according to the number of species are *Cyperaceae* (22), *Gramineae* (7), *Lythraceae* (5), *Scrophulariaceae* (4), *Hydrocharitaceae* (4), *Compositae* (4).

The species rather uncommon in the flora of Rajasthan but collected during the course

of present study are: *Spilanthes paniculata* Wall. ex DC., *Fimbristylis ovata* (Burm. f.) Kern, *Fuirena wallichiana* Kunth and *Oryza rufipogon* Griff.

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